Nonlinear Quantum Electrodynamics in Ultra-High Intensity Laser-Plasma Interactions

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An in-depth analysis of two recent studies on nonlinear QED effects relevant to large-scale numerical simulations of high-intensity laser-plasma interactions is presented. We demonstrate how accounting for plasma as a background different from vacuum affects the fundamental effects of nonlinear QED and quantify hitherto neglected QED coherences. In particular, we show how the background plasma can be included in the calculation of nonlinear QED amplitudes on the example of the emission of a single high-energy photon by a laser-driven electron with the laser experiencing a non-trivial dispersion relation due to its propagation through a background plasma. Second, we show how in laser-assisted pair production by a high-energy photon emitted from a laser-driven electron the usually employed incoherent assumption, i.e., the two QED processes of photon emission and pair production occurring at separate points in space-time, can become invalid.